Spin Correlations and Spurious Magnetism in $Nd_{2-x}Ce_xCuO_4$ I

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Antiferromagnetism in the electron-doped high-temperature superconductors is much more robust with respect to doping than in hole-doped materials. One qualitative explanation for this is the difference between dilution and frustration effects that result from adding carriers to different atomic orbitals.

We have measured the spin-spin correlation lengths in $Nd_{2-x}Ce_xCuO_4$ (NCCO) in the paramagnetic phase [1] at several Ce concentrations and compared them to quantum Monte Carlo simulations for the randomly-diluted spin-1/2 square lattice Heisenberg antiferromagnet [2]. We find that the results for NCCO are consistent with this model. However, we find a discrepancy between the size of the ordered magnetic moment of NCCO and that of the model system. These results indicate that quantum fluctuations manifest themselves differently for different observables.

Neutron scattering studies have demonstrated emergent magnetism in hole-doped materials when the superconducting state is partially suppressed upon the application of a magnetic field. Recently, Kang et al. [3] reported a similar effect in $Nd_{1.85}Ce_{0.15}CuO_4$. Unfortunately, these authors ignored a contribution from rare-earth paramagnetism emanating from a secondary decomposition phase of $(Nd,Ce)_2O_3$ that forms epitaxially

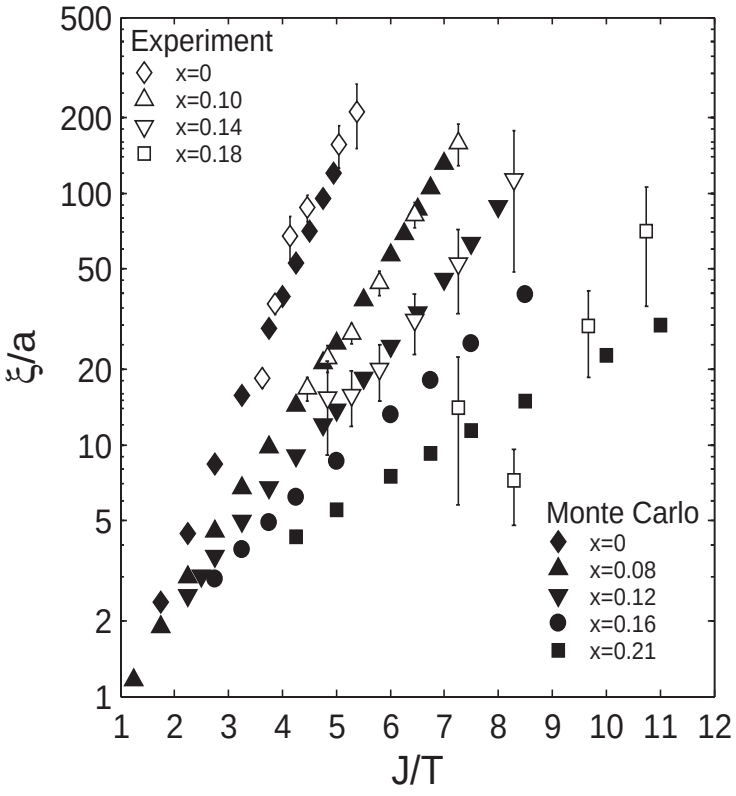

Figure 1: Semi-log plot of the magnetic correlation length (in units of the lattice constant a) versus inverse temperature (in units of the superexchange J=125 meV for Nd_2CuO_4). The data terminate just above the onset of Nεel order at low temperature. Quantum Monte Carlo results are also shown.

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inside the crystal when oxygen is removed from the lattice, a necessary step for superconductivity to be achieved.

Through a combination of careful structural x-ray and magnetic neutron scattering, we have demonstrated that the reported effect indeed is attributable to $(Nd,Ce)_2O_3$ [4]. This leaves open the question of genuine field effects on the copper-oxygen sheets in NCCO.

References:

[1] P.K. Mang et al., cond-mat/0307093.
[2] O.P. Vajk *et al.*, Science **295**, 1691 (2002).
[3] H.J. Kang et al., Nature **423**, 522 (2003).
[4] P.K. Mang et al., cond-mat/ 0308607, to appear in Nature.

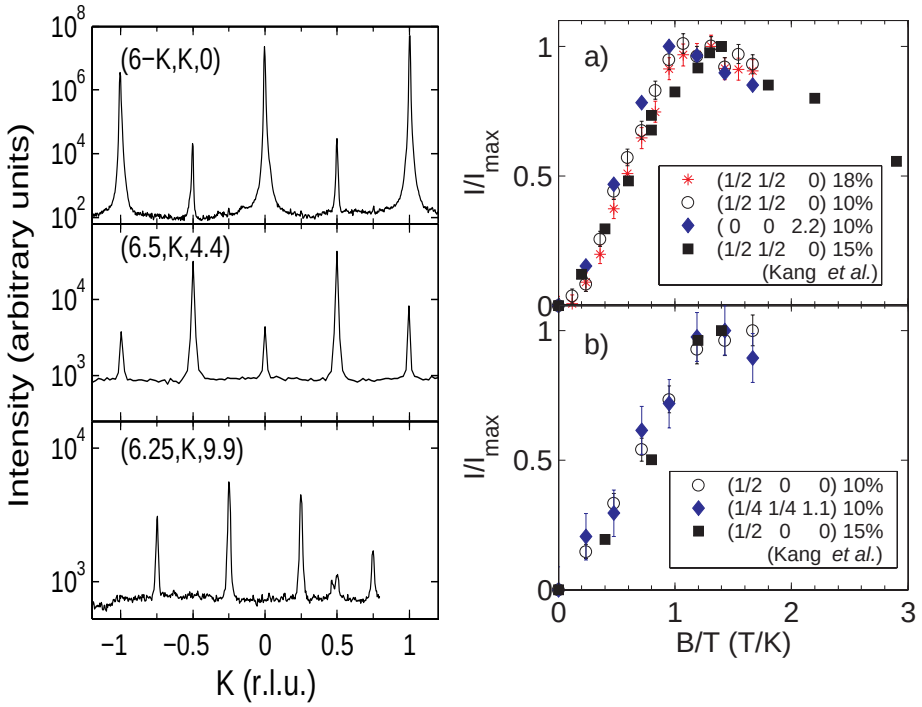

Figure 2: (left) Structural X-ray scattering reveals the presence of additional diffraction peaks emanating from a secondary phase of epitaxially oriented $(Nd,Ce)_2O_3$ inside the sample. (right) The magnetic neutron diffraction intensity can be scaled as a function of (B/T), demonstrating that the scattering is consistent with a paramagnetic origin. Moreover, the effect reported in [3] is also observed in a non-superconducting sample (x=10%).